April 11, 2000

Dr. Jerry Mahlman, Director
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Forrestal Campus
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Dear Jerry:

It has been challenging to properly frame this letter about the review of GFDL in view of your decision to retire soon after the review. I have decided to summarize the key points that the panel members brought to my attention and bring closure to the review. I have thoroughly considered the input of the panel and taken time to communicate with them personally as well as visit the laboratory and talk to most of the staff. Secondly, and more importantly, I want to inform you of my thoughts and plans on dealing with the upcoming change of leadership. I also hope to enlist your support for the successful recruitment of the new director and transition into the new millennium.

I commend the laboratory for receiving unanimous recognition of its scientific excellence in climate and weather research. The GFDL hallmarks of good experimental design, penetrative analysis and unambiguous conclusions have been sustained. This was attributed largely to the nurturing of exceptional scientific talent for many generations.

The following paragraphs discuss the key categories of issues brought up by the panel that I found in need of attention at this time. These issues regard the role of the laboratory within the climate and weather modeling community as well as within NOAA and its mission. Closely related are the issues relating to GFDL's partnerships. Finally some management, personnel and computing capability issues are discussed.

The committee explicitly discussed the role of GFDL in the weather and climate modeling community. As meteorology and oceanography mature and climate models become more sophisticated, they become long-term commitments and global in scale, and so require large teams. Such work will be tractable only in government laboratories taking a long-term view, rather than in universities, which operate on a much shorter cycle. GFDL is critical in sustaining the national effort and helping to facilitate collaboration with the university community. In addition, training and education must be considered an important part of NOAA's contribution to the community at GFDL.

I was quite impressed with the development of the Flexible Modeling System (FMS) as a shared modeling infrastructure, and its promise to enhance communication while reducing redundant efforts among the GFDL scientists. The panel recognized the benefits of developing FMS standards for physical parameterizations, sharing codes, and in transitioning to scalable computer architectures. It was specifically recommended that GFDL scientists contribute to the Weather Research and Forecast (WRF) model effort,

and I believe that you have already followed through on that suggestion. An important contribution would be the introduction of FMS standards to the WRF model framework, as a first step, the design of the column physics codes for WRF.

The reviewers stressed the importance of GFDL's role in supporting NOAA in its mission. Several recommended that the management clearly defines and articulates those goals and plans, and periodically evaluates and re-assigns research priorities. Dr. Lord made specific short-term suggestions by leveraging on his familiarity with the NCEP needs. There is a strong concern regarding the hurricane program, which has lost two key members recently, and is at marginal strength for carrying out the amount of work necessary to meet challenging NWS goals. The current resources at GFDL and NCEP are insufficient, given the challenges of maintaining an operational hurricane numerical forecast system at NCEP, and the new opportunities for improving this system by adding ocean coupling, improved assimilation of current observations and developing new assimilation methods for future data sources. In addition to the hurricane program, other parameterization developments, such as short- and long-wave radiation, will require GFDL and NWS/NCEP resource commitments for transition, so that improvements to NWS operations will be realized. Other projects with potential for improving NWS numerical forecast systems in the next several years include the Modular Ocean Model (MOM), Ocean Data Assimilation, and Ensemble Predictability Research. A near future endeavor is the development of forecast capabilities in the two-week to one-month range. Although it is not yet known what skill is achievable, and whether purely dynamical/numerical forecasts will prove sufficient, GFDL should develop plans in collaboration with NCEP and CDC for answering these important questions. Finally efforts of testing GFDL-developed parameterizations elsewhere, and testing of other parameterizations and modules at GFDL will be helpful for other applications besides climate. Such areas are precipitation and flood forecasting from land-falling hurricanes, a major component of NWS goals, and the U.S. Weather Research Program (USWRP).

The critical need for partnerships was brought up by all the review panel members in connection with the laboratory's role, priorities and science needs. The existing synergy between GFDL and Princeton is valuable and will grow in importance in the future. The stability and commitment to climate scale science provided by the laboratory, benefited by the university environment will permit high quality climate work for the long run. For the above reasons the move of the laboratory to the main campus was considered highly desirable. The committee also suggested seeking new partnerships as a means to strengthen the lab's accomplishments in certain areas and even broaden the scope of the work. In particular, GFDL can augment the effort in the land surface area by testing physical parameterizations developed outside GFDL, including land and surface modules. Collaborating with NCEP and NASA through the GCIP program is recommended. In addition involvement in diagnosis work of the global climate using satellite data can be accomplished by actively collaborating with organizations, which have been doing similar work and have a longer history of such efforts. Finally including expertise in understanding the observed ocean from the purely oceanographic side will greatly benefit the modeling effort and help the ocean data assimilation work.

The review committee felt the need to seek personal communication with the senior scientists and the young scientists of the laboratory and was unanimously impressed with

the overwhelming talent and promise of the staff. You have been extremely successful in securing a young generation of scientists who now dominate the laboratory. There is a very strong sense of community, almost a notion of family, among the staff at GFDL. However it came to our attention that the staff was unaware of problems facing the laboratory with regard to NOAA organizational and administrative issues. While the scientists were well insulated from potentially time-consuming bureaucratic tasks, as a drawback they were uninformed of emerging opportunities and discussions on broader agency issues. It is recommended that communication channels be set in place to increase interaction within the laboratory's divisions as well as participation of some staff in management issues. I am personally concerned about the reward system, to ensure that teamwork and other large community efforts (such as the FMS development), that do not result in peer reviewed publications, are adequately rewarded. It was recommended that NOAA sustained performance rewards could be a feasible venue.

A different aspect of personnel management has been thought of as needing urgent attention. The lab has made a conscious decision to put its resources into scientists, but although this is an understandable choice, a threshold may have been crossed in which productivity is reduced simply because of the lack of secretarial/business staff/clerical support.

The support staff issue was also addressed in connection with FMS, which represents the future of the laboratory as modeling and computing infrastructure and may well become a national example. Although it is expected to reduce the overall maintenance costs in the future, its survival depends on appropriate technical support staff. It would be efficient to employ one or two specialized people full time on maintenance and system development, rather than to share the work sporadically amongst a large number of scientists. Systems and software support are regarded as grossly inadequate. The laboratory requires secretarial and other staff support (business office, etc.) to avoid having the scientists spend time on essentially clerical tasks. GFDL' s computer support group needs to be strengthened for supporting modeling research, particularly software upgrades and day-to-day questions and chores, which accompany any computer intensive effort. It is suggested that contract services supplement the permanent staff and scientist-programmers be recruited and trained in software optimization techniques.

In view of the upcoming new computer procurement, members of the review panel recognized the importance of the considerable computing resources management. I think that following the suggestion to benefit from the FSL systems research experience may prove worthwhile for GFDL.

I would be interested to hear your views on the above comments and whether you plan to take specific actions on any suggestions. I have invited a small group of your colleagues to form a panel that will further consider these suggestions, and the role of GFDL within NOAA and within the weather and climate community. I expect that the group will meet a couple of times and exchange written materials over the next three months. The work of the panel will largely define and articulate GFDL's mission and provide the necessary qualifications of your successor, and thus will be fundamental to the recruiting process.

I hope that the future leadership of GFDL will be able to live up to your standard of excellence in science and communicating to the public as it shapes the future of the laboratory and maintains its legacy as a major national asset.

Sincerely,

David L. Evans

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL WEATHER SERVICE
NATIONAL CENTERS FOR ENVIRONMENTAL PREDICTION
WASHINGTON, D.C. 20233

November 10, 1999 W/NP2x1:SL

Dr. David L. Evans
Assistant Administrator for Ocean
and Atmospheric Research
SSMC-3, Room 11627
1315 East-West Highway
Silver Spring, Maryland 20910

Dear Dr. Evans:

The attached review is my contribution to the recent Program Review of the Geophysical Fluid Dynamics Laboratory (GFDL) on November 8-9, 1999. In sum, I recognize the overall excellence and exceedingly broad scope of the GFDL program and believe it has a vital role in our Nation's environmental research, particularly for climate. GFDL is going through a transition to a new supercomputer and is preparing for this challenge in part by developing the Flexible Modeling System (FMS). The possible relocation to the Princeton campus is seen as a very positive action and some unique opportunities for supplementing GFDL research activities may come from this. Finally, I have some concerns about marginally resourced projects, such as the hurricane model development, which are critical to National Weather Service (NWS) goals and National Oceanic and Atmospheric Administration (NOAA)'s mission.

It was a pleasure to take part in this review and I hope that it can be a positive contribution to an excellent program.

Sincerely,

Stephen J. Lord
Acting Director
Environmental Modeling Center

cc: J. Mahlman - GFDL

Review of the GFDL Program

It was immediately clear from the presentations during the course of this two day review that GFDL's research is continuing its outstanding tradition, particularly in the climate arena. The replication of global mean temperature over the last century is a major achievement and lends confidence to methodologies being developed for other climate forecasting scenarios. The scope of GFDL's work is extraordinary, ranging from climate and ocean modeling to the modeling of important mesoscale systems such as hurricanes. Relatively new forays into diagnosis of global climate using satellite data are of interest, but need more active collaborations with efforts at organizations which have been doing similar work and have a longer history of such efforts. Nevertheless, an active focal point for such work at GFDL to wider community efforts appears necessary.

A major cornerstone of GFDL's future success will be its upcoming computer procurement. Regardless of what supercomputer is chosen, preparation for a more unified modeling structure with the Flexible Modeling System (FMS) is an important step forward. Adequate procurement funds should be set aside to ensure that FMS becomes a well supported part of the GFDL computing and modeling infrastructure, and that GFDL scientists can return to a more efficient model development environment using FMS.

In view of the current community-based Weather Research and Forecast (WRF) model effort, it is important for GFDL scientists to contribute actively to this effort and to have the FMS infrastructure, including, software standards, considered for and hopefully merged with the WRF model. In particular, as a first step, the design of column physics codes for WRF could be done taking into account FMS standards. Merging of WRF and FMS would also create a modeling framework for mesoscale **and** global scale modeling, a truly ambitious but extremely rewarding goal. It might be possible in the future to hold a rotating series of WRF workshops at GFDL, National Centers for Environmental Prediction (NCEP), National Center for Atmospheric Research (NCAR), etc to bring together active participants in this large development effort and expose more of the scientific modeling community to this system.

During the review, it became apparent that GFDL's computer support group was not as strong as it will need to be for supporting future research needs, particularly for software upgrades and the day-to-day questions and chores which accompany any computer intensive effort. It is suggested that contract services supplement GFDL's permanent support staff and that some Masters Level scientist- programmers be recruited and trained in

software optimization techniques. Hopefully funds from the computer procurement will be sufficient for this purpose.

There is a strong, and growing, effort to develop improved physical parameterizations at GFDL. The radiation program is excellent and is being integrated into the FMS. Efforts in cumulus clouds, cloud coverage and microphysics are less developed but promising. The weakest effort is in the land surface area, and GFDL might profit substantially from major efforts at NCEP (in connection with GCIP program) and the National Aeronautics and Space Administration (NASA). Throughout its research program in physical parameterizations, GFDL should be in a position to test parameterizations developed outside GFDL, including land surface and hydrological modules. There should also be ample opportunities for testing GFDL-developed parameterizations elsewhere, such as in operational models. These efforts will be helpful for other applications besides climate, such as precipitation and flood forecastign from land-falling hurricanes, a major component of NWS goals and the U.S. Weather Research Program (USWRP).

A possible move to the Princeton Campus is seen as a major positive development, which would strengthen and stimulate GFDL's already formidable intellectual talent pool. Maintaining GFDL's identity as a NOAA Laboratory could be challenging but experience from the Norman Oklahoma complex (University of Oklahoma, National Severe Storms Laboratory, CAPS, NWS Forecast Office) could be helpful. Certainly GFDL's modeling infrastructure would be a major asset to Princeton's strong applied mathematics and geophysical science programs. It is strongly recommended that GFDL pursue this colocation vigorously and enlist active support, including administrative personnel, if necessary, from OAR leadership to help with the considerably complex planning activities. There are many opportunities here to expand the Atmospheric and Oceanic Sciences (AOS) program, which is already vital to GFDL's and the Nation's scientific future and which can be an even greater community asset. Training and education must be considered an important part of NOAA's contribution to the community at GFDL.

There was some concern expressed by GFDL employees about the amount of communication from management on important issues such as overall Laboratory scientific and computing directions and the possible Princeton move. This was undoubtedly due to the extremely full schedule of management rather than any purposeful exclusion. More frequent, e.g. quarterly, "all hands" meetings were suggested as well as the hiring of an administrative assistant to handle general support to the scientific cadre. Some concern was also expressed on the importance of rewarding "team players" as well those individuals whose scientific

achievements are evidenced by publications; this could be done through NOAA Sustained Performance awards rather than promotions, which would be difficult to justify in many circumstances.

There is a strong concern regarding the hurricane program, which has lost two key members recently. Even though replacing the retired Project Leader and the addition of a detailee from NCEP will help, this project is at marginal strength for carrying out the huge amount of work necessary to meet extremely challenging NWS goals. Meeting key NWS operational forecast goals depends critically on improved numerical models, and especially the GFDL hurricane model: National Hurricane Center forecasters emphasize that numerical guidance improvements drive improvements from operational forecasters. Given the challenges of maintaining an operational hurricane numerical forecast system at NCEP, and the new opportunities for improving this system by adding ocean coupling, improved assimilation of current observations and developing new assimilation methods for future data sources, the current resources for these efforts at GFDL and NCEP are insufficient. The FY2000 budget initiative amount of $1M for Hurricanes at Landfall should redress some of these deficiencies.

The transition of GFDL research development to NWS operations has major shortfalls in addition to the hurricane program as noted above. Parameterization developments, such as short- and long-wave radiation, will require GFDL and NWS/NCEP resource commitments for transition; otherwise, major potential improvements to NWS operations may not be realized. GFDL, Oceanic and Atmospheric Research (OAR) and NWS/NCEP management must produce feasible and mutually acceptable transition plans for testing, evaluation, implementation, operational maintenance and continued development of mature research from all NOAA Research Laboratories, not just GFDL. Other projects with potential for improving NWS numerical forecast systems in the next several years include the Modular Ocean Model (MOM), Ocean Data Assimilation , and Ensemble Predictability Research.

It appears that the time is ripe for considering the possibilities for developing forecast capabilities in the two week to one month time frame. GFDL, the OAR Climate Diagnostics Center (CDC) and NCEP should prepare a strategic plan for investigating and demonstrating possible forecast skill at these lead times. It is not clear what skill is achievable, and whether purely dynamical/numerical forecasts will prove sufficient, but the scientific talent at these organizations is among the best in the world for answering these important questions.

FILE COPY

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17 April 2000 R/E/GFDL

MEMORANDUM FOR: David L. Evans, Assistant Administrator

FROM: Jerry D. Mahlman, Director

SUBJECT: Summary and Synthesis of the Written Reviews of the 1999 GFDL Science Review

Thank you for your Review Synthesis of the written reviews from the November 1999 GFDL Science Review. Your analysis is thoughtful, comprehensive, and literate. Because of this, I choose not to abuse the privilege of your sending me a draft for comment by writing detailed suggestions/corrections. Overall, I do not believe that this letter requires such suggested small-scale changes.

There are two broad areas, however, that do appear to require (1) change by you and (2) factual corrections by me.

First, the letter lacks a sense of discipline as to where GFDL really needs to set its key priorities for increased commitments. The letter reflects the Review committee's lack of much discipline on the hard issues that require hard decisions and hard commitments, from both GFDL's and OAR's leadership. After all, the squeeze of declining research resources and increasing demands is an issue that we clearly share.

Second, there are a few places where the letter repeats some of the unexamined erroneous assumptions that came from the Review Committee members. Some of these misimpressions can either be dealt with by fixes to this draft, or in my official response later. I defer to you on which would be the better way to proceed.

Overall, I am very pleased with the value and the spirit of this Review Synthesis. All of the major suggestions are already being taken very seriously, although the magnitude of some of the responses will remain limited by the availability of financial resources for GFDL and OAR.

I look forward to working with you and with the GFDL staff to make optimal use of this summary and synthesis letter, and of the more detailed Reviewers' letters, for the continued improvement of research and services in GFDL and OAR.

cc: B. Ross
L. Tsaoussi

Science review
GFDL, 8-9th November 1999
J F B Mitchell

The scientific presentations made at the review confirmed my impression gained from recent publications that GFDL continues to produce work of the highest scientific standard. The GFDL hallmarks of good experimental design, penetrative analysis and clear unambiguous conclusions have been preserved, despite some of the key senior staff having retired in the last few years. This is tribute to the depth of talent that has been nurtured in the organisation. In addition, some very able new staff have been recruited, often aided through the Graduate program run with Princeton University. These two factors should ensure that the level of creative activity and high intellectual standards associated with GFDL will be maintained. In addition, I continue to be impressed with the friendly atmosphere among the staff and their courtesy to visitors. My main message is that the science in GFDL is in good shape.

There are some issues that need to be considered. Many of these are common to other research centres, and should be kept in the perspective of the quality and quantity of science presented during the review. The comments are intended to help in fine tuning the progress of the laboratory.

1. The number of forecast and climate products expected from GFDL is likely to increase markedly in the next few years. This is against a background of diminishing resources. The laboratory will have to guard against spreading its effort too thinly. Options to avoid this include ending some existing activities and choosing the new areas carefully, not trying to compete across the board.

2. The gradual reduction in resources has been met in a number of ways. In particular, the number of support staff needed has been reduced as scientists can now do much of their own analysis using general software tools on workstations. In future, it is hoped that the new flexible modelling system (FMS) will reduce the time spent on maintaining models. However, there are still numerous low-level talks which cannot be automated, and these fall increasingly to junior scientists as support posts are not renewed. At some stage this must become counterproductive- at best it leads to dissatisfaction amongst junior scientists, and at worst it means the government is paying highly qualified scientists well above the odds for routine systems support. This comment is particularly relevant to the development and maintenance of the flexible modelling system. Our experience with the unified model is that it does reduce the overall maintenance costs, but maintenance and system development become more specialised. As a result, it is more efficient to employ one or two people full time on this task, rather than to share the work sporadically amongst a large number of scientists. A similar comment applies to my perceived shortage of administrative staff. Does it make sense to pay scientists to do routine administrative tasks, or for each individual to learn detailed administrative procedures when a trained administrative officer can do it much more efficiently and cheaply?

3. Some of the efficiency of GFDL has been achieved through having a flatter management structure and keeping meetings to a minimum. I strongly approve of this in principle. However, our talks with both group leaders and younger scientists suggest that this may have been slightly overdone. Both groups expressed the desire for a wider dissemination (communication "up and down" appears to be satisfactory, but communication "across" is poor). This could be improved by more frequent meetings between the Director and Group Leaders, and occasionally between the Director and all staff. (In the Hadley Centre, the Director meets with all group leaders together formally at least once a month, and with all staff, including administration and computing staff, once a month. For the full group, I suspect once a quarter would be adequate- if they are not

planned and held regularly, my experience is that after a while they don't happen). My impression was that the quality of communication between Group Leaders and their groups varied from leader to leader, and in some cases was not always satisfactory. In general, I felt the communication within the laboratory needed to be proactive, not just responsive.

4. The nature of the supplier - customer relationship between GFDL and other bodies was unclear to me. In particular, it was not obvious how much the laboratory should be responsible for helping make their products operational, and for any further support, and whether or not there is a clean "signing off" procedure to release GFDL resources once operational models were running.

5. The Flexible Modelling System is an ambitious project on which the laboratory is basing much of its future. I believe it will need some kind of formal management system, in order to contain its cost, and to ensure that the division of labour is fair and effective. A related but separate issue is the construction of the new model, especially a new coupled ocean-atmosphere model. It is not sufficient to string together "improved" physics and dynamics routines. Our own experience is that a lot of further work involving a number of different disciplines is required to produce good coupled simulations, particularly if flux adjustments are not to be used, and as model complexity increases. This "across group " activity may also require a degree of formal management

In summary, I believe that GFDL has maintained its scientific excellence, and is likely to do so in the future. If the laboratory is to expand its work into existing or into new areas, then it will need to acquire extra resources or redirect some of its current resources. There are some minor issues concerning support infrastructure, communication and management of central facilities that need attention.

Review of the Geophysical Fluid Dynamics Laboratory

David P. Rogers
Scripps Institution of Oceanography
La Jolla, CA 92093-0230

General Comments

This review assessed the scientific and technical activities of the laboratory and, at the request of the reviewers, we also considered the administrative structure of the organization. The public section of the review consisted of a series of presentations from various members of the laboratory and collaborators from Princeton University. The reviewers requested that this portion of the review be reduced to facilitate more direct contact with laboratory staff. This was agreed and the reviewers held two meetings with laboratory staff: one with the section leaders, and one with the more junior members of the staff.

Including the most pertinent information relevant to the presentations into a single document would have been helpful for the reviewers and this reviewer, in particular, would have preferred a more integrated view of the laboratory's research activities. Overall there is ample evidence of the accomplishments of the GFDL staff, although it was less clear from the presentation how each fits together into GFDL's integrated research strategy. A detailed assessment of specific projects is not possible from the review material presented. No advanced material was provided to this reviewer and only general comments on the quality of the research can made. The GFDL activities and plans document gives a very comprehensive overview of the organization and I would have liked a copy before the review to guide my comments and questions. One might be forgiven for thinking that the review process was not taken very seriously by the laboratory.

Specific Comments

GFDL Structure

GFDL is focused primarily on the numerical simulation of the ocean – atmosphere system on scales pertinent to the NOAA strategic planning elements. The laboratory has a very strong record of accomplishments within the atmospheric and oceanographic research communities and is perhaps best known for its contribution to hurricane forecasting. GFDL operates in very close collaboration with Princeton University, operating a joint program and many members of the GFDL staff hold appointments at Princeton. The laboratory has a similar structure to a university department with hiring practices, teaching assignments and resources distributed in a similar fashion. GFDL appears to be a largely autonomous organization that prides itself on its independence from NOAA, and close ties with the university community both nationally and

internationally. The laboratory pursues mostly basic research. In my own experience at the University of California, it appears most similar to the Marine Physical Laboratory at Scripps, which traditionally obtained most of its support from the Navy to solve specific problems that benefited from the intellectual resources of an academic institution.

The 1969 stated mission of GFDL is "to conduct investigations of the dynamics and physics of geophysical fluid systems to develop a theoretical basis, by mathematical modeling and computer simulation, for the behavior and properties of the atmosphere and oceans." This is being revised with an interim mission, which states that "GFDL is to conduct mathematical modeling research on atmosphere-ocean system to provide: fundamental underpinning of NOAA's science based mission; improve NOAA weather and short-term climate predictions and services; and policy-neutral scientific information to the Nation on major environmental problems. This refocus seems appropriate considering the growth in numerical modeling and computer simulation of fluid systems within the university community in the last thirty years. To maintain a unique niche in the nation, it is important that GFDL focus primarily on the requirements of NOAA.

From the overall tone of the review, I was left with the impression that GFDL is focused primarily on curiosity driven research, teaching and student supervision, emulating a typical university department. Several of the presentations actually expressed contradictory views, which one would associate with the lack of coordination of research activities usually found in universities.

This begs the question what role does GFDL fulfill for NOAA? Does NOAA want an academic laboratory, in effect its own university department of geophysical fluid dynamics, or should GFDL act more as a transition element between university research and NOAA operational requirements? None of the research presented during the review is unique to GFDL. It is certainly of a very high quality, but one wonders whether GFDL is underselling its role in the community by being one amongst many organizations with similar research capabilities. The wider search community has evolved in the last thirty years while GFDL appears to have remained largely the same organization that was conceived in 1969. It is also unclear how GFDL relates to the other OAR laboratories or to national modeling priorities such as the WRF. At present, despite the expertise at GFDL, there is no involvement in this national program.

Finding: The general increase in computing and modeling research at many universities and other government organizations has reduced the unique role of GFDL as the geophysical fluid dynamics laboratory.

Recommendation: Management needs to focus on how the GFDL effort will contribute to the NOAA mission rather than merely stating that it does. Attention should be given to how the GFDL effort fits with the other NOAA OAR laboratory research plans and in the larger context of major activities within other national laboratories.

Research Priorities

GFDL research is focused on climate dynamics, ocean circulation, climate diagnostics, atmospheric processes, hurricane dynamics, experimental prediction and mesoscale dynamics. The absence of soft-money research and the diminishing value of base funding in real terms reduces the flexibility of an organization that gives equal priority to all of its existing research activities. It was stated that they have reprogrammed efforts and there is not much scope for further redirection. Noting that their research is largely mainstream atmospheric science with similar expertise at NCAR and within the university community, it should be possible to redirect efforts by coordinating research efforts more effectively with other organizations. The director stated that there are several areas that they would like to pursue, most notably data assimilation, but lack of NOAA support for an initiative in this area has prevented the laboratory from pursuing this activity. Data assimilation is widely recognized as a necessary step in improving oceanic and atmospheric numerical models. Research efforts, such as GODAE are leading the way in the oceanographic community and the National Ocean Partnership Program is providing support for new research efforts in this area. The policy of not seeking outside support effectively bars GFDL from participating in these efforts.

Finding: GFDL has created a research environment with little or no flexibility to initiative new programs.

Recommendations: GFDL should aim to create flexibility within its base funding to support short-term research efforts with internal funds. Approximately 10% of the budget should be available for new initiatives. Review priorities in research and reduce effort in lower priority areas to create more flexibility.

Finding: While there is evidence of collaboration with other research organizations, GFDL's management of research priorities appears to be isolated from outside influence. Similar research activities are underway at other national laboratories and universities and should be considered in setting laboratory priorities.

Recommendation: NOAA management and GFDL management need to work together to increase budgetary flexibility by identifying external collaborators that can share research costs.

Recruitment and staff issues

Staff recruitment is based on acquiring the best talent from any targeted research area. However, there appears to be relatively little focus on the prioritization of research. Recruitment also seems to occur at the expense of support staff. Ultimately this reduces the effectiveness of the research staff. The junior staff indicated that they would welcome more computer support staff. The group leaders echoed this view.

The junior staff voiced concerns about the lack of mentoring and career advice within GFDL. Many viewed the promotion system as a "black box". They appeared pleased that the director protected them from the "NOAA bureaucracy"; however, this implies a

disconnection between other parts of NOAA and the researchers within GFDL resulting in a lack of familiarity with the issues that might benefit from their involvement and expertise. Also there is confusion about the possible the move from the present site to the main Princeton University campus and the implications for the staff not considered part of the university faculty. The disparity between university and federal salaries will become an increasingly significant issue.

It was also brought to our attention that the management of GFDL is vested entirely with the director. There is no forum for the exchange of ideas and discussion of issues amongst the senior management. This suggests that there is no shared governance, no mechanism to decide on new directions for the laboratory collectively, and no "buy-in" from the staff to the mission of GFDL within NOAA. The desire to participate in decision-making within the laboratory was expressed by many of the junior staff.

Finding: GFDL staff does not play a significant role in the management of the laboratory. This has created communication problems at all levels.

Recommendation: Create a structure that increases the participation of the staff in the management of the laboratory and increases the awareness of the laboratory staff of broader NOAA issues.

Finding: Present method of appointing staff is inconsistent with the prioritization of research activities. Experience elsewhere suggests that finding the best talent is not inconsistent with a focus on a prioritized research area

Recommendation: Review the GFDL hiring process to ensure that the selection of new staff is consistent with research priorities.

Finding: Present method of appointing staff favors academic rather than support staff when more of the latter may be needed.

Recommendation: Review research programs to ensure that they are sufficient support staff to accomplish the research mission.

Soft-Money Support

NOAA is almost exclusively the source of funding for GFDL. The impression was conveyed that this is the most desirable funding profile. The director suggested that any reliance on soft-money research would somehow undermine the laboratory. This seems misguided. While it is appropriate to maintain a large fraction of NOAA support from GFDL, discouraging support for other activities that are pertinent to the NOAA mission is undesirable. Without a proven track record of independent funding support, the junior academic staff will at a disadvantage if applying for university appointments in the future.

Discussions with the junior staff suggested that the administrative structure is not set up to oversee contracts and grants from non-NOAA sources and several examples of principal investigators trying to run their own contract administration were given. Clearly there is an institutional disincentive to seeking non-NOAA support; however relevant to the NOAA and GFDL missions.

Soft-money can be used to provide flexibility in research activities within the laboratory. Properly managed these funds would provide the laboratory with opportunities to test out new research areas without making long-term financial commitments from base.

Finding: On the one hand the laboratory acts like a university department; on the other, there is an active disincentive to obtaining non-NOAA soft-money support.

Recommendation: Develop a GFDL-wide strategy to obtain soft-money support for new research areas that fit the strategic mission of the laboratory and leverage NOAA support in areas central to the NOAA mission.

Recommendation: Review laboratory administration to enable efficient oversight of external contracts.

Recommendation: Review laboratory policy on non-NOAA funding with aim of increasing support to between 10 and 20%.

Computing and Modeling Issues

Huge resources are tied up with a new computer acquisition. How these are used for the general benefit of NOAA is unclear. Will this help other NOAA laboratories accomplish their mission? The apparent lack of cooperation with FSL and other organizations is unfortunate considering the enormous expertise that exists in other centers. Vector, parallel and hybrid systems research is underway in many locations and GFDL should benefit from this work. FSL and the San Diego Supercomputer Center might be a good place to start.

It is unclear how the numerical modeling effort at GFDL fits with other NOAA led modeling activities such as WRF and various programs at FSL. It would be in the best interest of NOAA to see some specific coordination and integration of these activities.

Finding: NOAA OAR has several efforts underway to acquire new computers and to apply new computing techniques to numerical modeling and simulation. It is not clear whether any of these efforts fit together and if so are efficiencies possible in the management and use of these resources.

Recommendation: In view of the huge resources involved, recommend an OAR review of computing needs and capacity and the development of plans to share these resources amongst the laboratories.

Finding: GFDL appears to have too few staff dedicated to the support of its computing system and programming efforts.

Recommendation: Review staffing needs and reserve resources for support staff.

National Center for Atmospheric Research
Climate Change Research Section • Climate and Global Dynamics Division
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29 November 1999

Dr. David L. Evans
NOAA
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Silver Spring, MD 20910-3282

Dear Dave:

It was good to see you at the GFDL review and have a chance to chat with you in an informal setting at dinner. My individual comments on the review are given below.

First of all, I have to admit some bias, since the research conducted at GFDL overlaps strongly with my research in climate modeling. About 7 years ago, when I was Director of the Climate and Global Dynamics Division as NCAR, I asked Jerry Mahlman to conduct a review of the division. When Jerry called me and asked if I could help in the review, I was pleased to return the favor.

My first comment is that I was very pleased to see the state-of-the-art science being carried on at GFDL by a new generation of scientists. The presentations by the scientists demonstrated very significant advances in the understanding of weather and climate related science. It is, also, impressive to see the trend toward building better and more realistic models. In the early days of climate modeling, it was very important that climate models capture the basic dynamics of the climate and weather systems. Compromises were made toward lower resolution and more simple physics but still capturing the basic dynamics of the weather and climate systems. As we go into the next century, we are capable of improving many of the aspects of the models with a higher degree of reality. Through gentle but consistent leadership, there is a laboratory wide effort to consolidate versions of models into a more common coding framework. This Flexible Modeling System (FMS) will greatly aid research in the long term. Care should be taken to use nudging of the staff rather than "orders from the top." That looks like what is happening. In the discussion with the senior staff they did stress there is a need for more structure in the FMS project.

Jerry and his senior staff have done an excellent job of attracting new young scientists to join GFDL. I was pleased to see that the younger staff is given an opportunity to collaborate or strike out on their own in there respective areas. The

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presentations by many of them showed that they are full of energy. However, I was disappointed to see few women or minorities at GFDL. I know that Jerry and others have helped some get their doctorates as part of the Princeton program with GFDL. Discussions with Jerry lamented their efforts with Black and other minority institutions but that has had very little success. This is not due to lack of trying but a larger problem of attracting more minorities into science in general. I hope that GFDL will still keep looking for that precious few because it has a reputation for developing excellent scientists with high standards.

There are a number of issues that I would like to comment on and I hope that management at NOAA and GFDL understand the limitations of making judgments from brief presentations.

1. The Princeton's Atmospheric and Oceanic Science Program seems effective but not a particularly strong interaction. I think part of the reason is that Princeton has only a limited number of professors that can interact. Moving to the main campus will help but it is not likely going to lead Princeton to being in the top five departments in the country. The quality of the graduates is excellent but not likely to grow much.

2. Clearly, it is good news that Congress and the Executive Branch have seen fit to augment the computer at GFDL. The management of the procurement is in good hands. My only concern is that there be more flexibility in the coding for a particular machine. My experience at NCAR suggests you find a few computer scientists that have degrees or experience in atmospheric or ocean sciences. Because you are likely to get a clustered parallel computer system, you should look at the MPI method between nodes and open message passing within a node method. This hybrid approach will help develop more flexible code. I know you hope to keep this invisible to the scientific programmers but that may be a mistake given the difficult task of fixing up codes after the fact. Jerry remarked that the number of collaborators has increased substantially over the last few years. This may be an opportunity of setting aside a small percentage of computer time for new collaborators in the GFDL program. Several made comments to me that there needs to be a review of the historical pattern of computer allocation. The easiest time to reallocate is when a new computer becomes available.

3. The improvements and generalization of MOM is great. It appears that the differences between the LANL POP code and MOM will not be great. MOM will always have more documentation and POP may be a bit more tuned to parallel computer systems. The features presented seem quite similar.

4. The land surface component seems to be well connected scientifically to the field experiment community and others in this area of research.

5. The Hurricane Forecast System research is getting sub-critical in terms of size. The question for management is whether it is sufficiently close to operational that it should be further developed in the NCEP framework. This is a fundamental research question or a development task. I suspect it is still both.

6. The Cyclone and Larger-Scale Interaction research seems to be making contributions but it is not as exciting as it used to be. It may bear fruit on the longer than a week forecasting skill.

7. The seasonal-interannual prediction research is competing with many other groups, some of which are in the NOAA family. I think it is important that GFDL stay in the battle if for no other reason than it helps build better future climate models. The climate diagnostic from SST anomalies forcing of the atmosphere is also very valuable research and has improved our understanding of basic forcing of the atmospheric planetary waves.

8. The climate simulations of global warming, 20th century warming, and paleoclimates are excellent examples of careful and scientifically interesting experiments. GFDL needs to remain a leader in these areas of climate research.

9. Improvements of radiation, convection, moist physics, etc. all seem to be carried out by scientists who know what they are talking about. One of the caveats is whether such processes as clouds are more complex but still wrong in significant ways. The various DOE/ARM, satellite, and field experiment data should be used to a maxima to find out if the parameterizations are correct. I was pleased to hear that GFDL scientists are fully engaged and working with the observed data scientists outside of the laboratory.

10. The atmospheric chemistry program seems quite weak and apparently it is hard to find someone. This may be an opportunity to join another NOAA laboratory or university department in working together. Distance interactions should be explored.

11. It is imperative that GFDL continue to play a major role in the IPCC and National Assessments. This may not be as exciting as some other research programs but it has great societal relevance. Each assessment gets better and GFDL needs to do its part.

12. Jerry talked about the growing role of GFDL in supplying information to a large number of community, many of which are outside of the traditional Geosciences. I encourage this strongly as the way of the future.

13. I am no expert on data assimilation and I know this has been a laboratory high priority for several years without much success. As time goes on this will be more operational research then fundamental research. If resources can not be obtained, GFDL may want to find effective collaborators in other organizations.

14. Management issues were discussed with the group leaders and the younger scientists. I detected no problem with the top leadership and an endorsement of continuing the style of strong leadership. They did identify areas that need more attention. Some of this will be difficult because of the emphasis on hiring scientific talent rather than hiring more scientific support and general administrative support. We saw many signs that GFDL is getting at the ragged edge of the latter support. Several mentioned to me that the deputy, Bruce Ross, is doing a great job but has too many responsibilities, The staff spends too much time on routine tasks, which could be more effectively done with others. We, also, heard that computational staff is too limited, especially, as GFDL goes more into the parallel computer paradigm. Being a former director, I know that completely satisfying the need of scientists is impossible. The big question for Jerry is whether this is a time to take care of some of the infrastructure needs. With respect to communication with the staff, if you have more meetings they complain and if you have too few they complain. In this case a bit more general staff town meetings and more discussion with your senior staff may help transition GFDL into the new areas. Some of the younger scientists voiced concerns about not knowing enough about the promotional system at GFDL and with any organization there is a perception that the process is uneven throughout the laboratory. This could be easily straightened out by a meeting. In fact, GFDL could probably benefit from a more detailed plan long-term for hiring. This should be discussed with the senior managers.

I may have covered too many areas in my review and it could be better articulated. Impressions from a two-day visit may be wrong and I understand that. Please let me know if I can be of help in clarifying any points.

Sincerely,

Warren M. Washington

cc: Jerry Mahlman
Bruce Ross

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16 November 1999

Dr. David Evans, Associate Administrator
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Dear Dave:

This letter is my version of the report on the Geophysical Fluid Dynamics Laboratory, Princeton, from the recent Visit.

First, I was very pleasantly surprised to see that GFDL has managed to successfully rejuvenate itself over the past few years. When I spent five months there six years ago, it looked like the Laboratory was coasting on past glories, with its stars all aging and nearing retirement. That GFDL is now dominated by a younger generation of very promising people is a considerable tribute to the leadership of the laboratory.

Neither I nor (to my knowledge) the rest of the committee, found any problems which would lead one to say there is any kind of looming crisis, or any problem so bad that one would call urgent attention to it (with one exception). As is always true, there are things which could be better, and some of which will eventually become very important if not addressed in the near-term.

Almost unanimously, we were told that internal communication within the Laboratory was inadequate. There is widespread appreciation that the Director and his Deputy work very hard to insulate the scientists from bureaucratic problems coming from NOAA (I will not repeat the usual, and endless generic, and justified, complaints about NOAA), but that often the absence of any information leads to rumors and a sense of being in the dark. This feeling extends (particularly) to the group leaders. There appear to be no internal forums for simply keeping people informed of discussions, opportunities, or the problems facing the Director. Someone stated explicitly that it wasn't that they wanted to make the decisions, but that they merely wanted some understanding of what those decisions might be. (An analogy might be my experience on the way home. We sat out on the runway for 45 minutes with not a word of explanation from the pilot. As passengers, we weren't going to affect the operation of the aircraft, but some of us, at least, would have appreciated some words about why we were sitting there and when it might end.)

Related to this issue is the need to sustain continuing evaluations of what GFDL is meant to do, now and in the future. As meteorology and oceanography mature, they become much more complex, and with the shift toward climate problems, many more problems become long-term, and global in scale, and so require large teams. They will be tractable only in government laboratories taking a long-term view, rather than in universities which operate on a much shorter cycle. At the present time, GFDL has focussed on securing individual stars, and only secondarily worried about exactly how they would fit the Lab's overall course. To a great extent, this is how university departments function too, and that model of operation may well become inappropriate.

The issue of technology transfer to NCEP and elsewhere in NOAA I will not address, as I believe other, more knowledgeable members of the Committee will do so. We did not get a very clear sense of whether there were any problems of internal promotion, or of individual understanding of their status and prospects, other than the comment that mentoring was uneven (it always is). But one can see some potential problems. Functions at GFDL such as software documentation are extremely important to a wide community inside and outside GFDL (e.g., MOM, the hurricane work etc.). But this is not the sort of work that individual scientists get much external recognition for (not peer-reviewed publications). No one seemed very clear on whether or how such community contributions were weighed or evaluated relative to normal publications.

There appears to be a nearly unanimous belief that staff support (business office, etc.) is totally inadequate, and there appears to be no secretarial help whatever for the scientists. The latter are spending hours and days doing essentially clerical tasks. Outside grant support, when obtained, cannot be handled internally because of the lack of staff. As a quality-of-life issue, this emerged as the one item which several people stated could eventually lead them to leave GFDL. The Lab has made a conscious decision to put its resources into scientists, but although this is a reasonable choice, a threshold may have been crossed in which productivity is reduced simply because of the lack of secretarial/business staff/clerical support. The Flexible Modelling System appears to be working and may well become a national example, but it will not survive on the basis of a single individual leader, without appropriate technical support staff.

In a related area, systems and software support are regarded as grossly inadequate, and the entire systems area could potentially collapse, which would be ruinous to a place like GFDL. This is one area needing urgent attention.

Assuming the move is made to the main Princeton campus (something I would urge as being of the greatest importance), it represents an opportunity to engage the University management in a way which seems only to recur at intervals of several decades. The University/GFDL connection can only grow in importance in the next years. As both oceanographic and meteorological communities shift toward climate problems and everything becomes more complex, the research universities are struggling to obtain and retain younger faculty able to both do important science and do it on the very short time-scales of university tenure and promotion. We are already seeing the disappearance of these fields in the front-rank US and European research universities.

Princeton and GFDL may become uniquely valuable as a place where the flexibility of the two very different organizations will permit high quality, climate scale science to be carried out, and in the presence of good students. The teaching function of the GFDL people on the Princeton faculty is a positive activity for both the government and the university. It needs to be sustained.

On the purely oceanographic side, GFDL/University remains weak in understanding of the observed ocean. In meteorology, there are several people within GFDL who can be relied upon for a deep understanding of the observations. No one like that is available within the Princeton community for oceanography, and I believe this has led to serious issues of credibility, in some of the modeling work. It really only takes one person to act as a wider resource. I don't believe relying on collaborations elsewhere is remotely as effective as having someone down the hall or down the street who is available at all times for input. If the data assimilation effort ever does get going, this problem will have to be solved as a matter of urgency (data assimilation is done in many places as an abstract, mathematical, exercise, and that will not serve GFDL nor the country.)

I'm omitting lots of small details, some of which were touched upon in our discussions with Jerry and Bruce. My summary would be that GFDL seems well-placed, in principle, to sustain its role as a major national asset. It is, however, organized to operate as a benevolent dictatorship, one in which the leader has to have a strong scientific sense and a rare ability to deal with the government bureaucracy above him. Whether NOAA will always be able to find such individuals is unclear to me, but whether NOAA-GFDL relationship can be structured so as to render the Lab less vulnerable to possible future leadership weaknesses is a very difficult question for an outsider to answer.

A minor comment. The review process itself was not really optimal. The committee felt overwhelmed with AGU-style talks and had to seek a change in the second day. We also thought that it would have been a bit less awkward had someone been asked to be chairman. Although it all worked out in the end, there probably needs to be a greater opportunity for the visiting committee to meet informally with staff at various levels and in various group sizes. Perhaps the committee should divide up for part of the time.

I hope these comments will prove of some use.

Sincerely,

Carl Wunsch
Cecil and Ida Green Professor
of Physical Oceanography

xc: J. Mahlman